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IS THE NEW ECTS SYSTEM BETTER THAN THE TRADITIONAL ONE?

An application to the ECTS pilot-project at the University Pablo de Olavide.

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ABSTRACT

At the meeting of the joint Bologna Declaration, EU representatives agreed on the establishment of a common *European Higher Education Area* by 2010. Since then, several universities have implemented pilot projects, although no formal research has been carried out to analyse their results. In this study, we analysed one of these pilot projects with two objectives. First, we examined the performance of the new system as compared to that of the traditional system. We used a procedure based on a modified model of *Data Envelopment Analysis* that is able to distinguish students' efficiency (*managerial efficiency*) from efficiency based on the educational programme used (*programme efficiency*). Then we analysed whether the different systems perform differently for different types of students.

Keywords: Data Envelopment Analysis, efficiency, education, programme efficiency, ECTS, *European Higher Education Area*.

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INTRODUCTION

By the end of the last century, the countries of the European Union (EU) had reached many important agreements and had taken significant steps towards deeper integration. Among these steps, the elimination of trade frontiers, economic convergence and the monetary union associated with the establishment of the euro were significant; however, by the end of the nineties, and despite the steps given in the educational frame, there were huge differences among the university systems of the different countries. The first steps towards developing a unique space of higher education for all of the European countries were not taken until 1998 at the meeting of the Sorbonne Joint Declaration. There, the signatory members established 2010 as the deadline for implementing a new educational programme.

The agreement they reached at the Sorbonne Joint Declaration represented an institutional commitment to promoting a common educational structure that would create greater compatibility and comparability among national systems of higher education (HE), which would lead to greater student mobility across the EU through the use of a *European Credit Transfer System* (ECTS). The commitment to establishing a *European Area of Higher Education* (EHEA) by 2010 has encouraged some European universities to carry out pilot-projects related to the ECTS.

The objective of this paper is twofold. First, we have analysed the changes in efficiency that have occurred because of these changes in the education system. This has been done by comparing the efficiency of the education programme before and after a Euro-Credit pilot-project implemented at Pablo de Olavide University. The analysis was carried out using a modified procedure based on a model of Data Envelopment Analysis that combines the Charnes, Cooper and Rhodes (1981) procedure and the Banker, Charnes and Cooper (1984) model. This procedure can be used to distinguish *managerial efficiency* (the efficiency inherent to each individual student) from *programme efficiency* (efficiency as related to the educational programme used). The second purpose of this study has been to verify whether programme efficiency was similar for all students, or whether, depending on the quality of the students, one or another system performs better.

Several approaches to measuring efficiency can be found in the literature (see Herrero, 2005); however, the literature shows that the *Data Envelopment Analysis* (DEA) method appears to be the most common in the field of education (Miranda and Lanzer, 2003; Melville, Mc

Millan and Wing, 2004; Johnes, 2006; García-Arancil and Navarro-Milla, 2006; Martin, 2006; Fandel, 2007, Muñiz, 2002, Tauer, 2007).

At the Pablo de Olavide University (UPO), the implementation of the pilot-project for the ECTS for the BA in Business Administration (LADE) was carried out during the academic year of 2005/06. Therefore, the purpose of this paper is to comparatively analyse the efficiency among students who began their first-year studies in Business Administration in the 2004/05 academic year and those students who began their studies in 2005/06; this will allow us to determine whether the use of the ECTS in the first year of LADE at UPO has given rise to a higher efficiency rate. Furthermore, we have extended the analysis by searching for variables that can help us explain the efficiency level of the student.

The rest of the paper is divided into six sections. In the first and second sections, we have reviewed the literature on efficiency measurement and the EHEA at the European level. Then, we have explained our methodology (a modified DEA model, Charnes *et al.*, 1981) and the variables used. In the fifth section, we have presented the results. Finally, we have drawn some conclusions based on our analysis.

STATE OF THE ART

The idea of creating a *European Higher Education Area* (EHEA) began with the Sorbona Declaration (25 May 1998), but it was at the Bologna Declaration (19 June 1999), with the participation of 30 European states, including Spain, that the process of creating the EHEA began. The key objectives formulated in the joint Bologna Declaration are the attainment of a higher level of compatibility and comparability among national systems of higher education and an increase in the competitiveness of the European System of Higher Education (Ramos, 2008).

The European Commission has established that the convergence process will be implemented through several key documents, such as the learning agreement (which contains the list of credit points that will be awarded for each course), the Transcript of Records for each student (a list of courses taken and ECTS credits obtained by the student) and the Diploma Supplement (a standardised description of the studies completed by the graduate). These documents aim to facilitate the academic and professional recognition of qualifications and

study completed abroad (diplomas, degrees, certificates, etc.), with the aim of establishing a common framework of comparable degrees and improving international ‘transparency’.

In addition to standardising documents and increasing student mobility, ECTS implementation will imply a substantial renovation of the Spanish educational system. The new educational system (ECTS) attempts to increase the quality of teaching and to increase the individualized attention for students. Spain is one of the countries for which this change will be particularly dramatic. The traditional system (TS) in Spain is based almost entirely on the number of teaching hours, whereas the ECTS is a student-centred system focused on the student workload required to achieve the objectives of a programme. Furthermore, these objectives are to be specified in terms of the learning outcomes and competences to be achieved. Therefore, credits will only be obtained upon completion of the workload and after a successful assessment of those learning outcomes and competences. While the traditional Spanish system has the aim of making students acquire a vast amount of knowledge, the new system is focused on students’ ability to learn by themselves. The scholar, rather than simply transmitting knowledge, should be a person that is able to “teach to learn” in order to promote self-learning. This will help students to not only obtain certain knowledge during their course of study, but also to “learn how to learn” by themselves. This, in turn, will encourage *life-long learning* (LLL), in which the student will be able to learn by himself during his entire academic and professional life.

Therefore, the new system encourages students to develop important abilities and competences, including written and oral communication, self-learning, research ability, skills related to teamwork, etc. Toward this end, students should develop some academic projects with the supervision of a teacher. This change in educational methodology will be especially challenging in Spain, where the educational system has traditionally been focused on content and written evaluations rather than on other abilities.

One of the most important changes in the new educational system is that assessment in the ECTS is based on ongoing evaluation. In this system, the teacher regularly supervises student work. This encourages students to study on a daily basis. By contrast, in the Spanish higher education traditional system (TS), assessment is based on achievement testing, with the result that some students do not study much during the semester, only focusing on their studies

when exams are imminent. This trend has probably come about partially as a result of overcrowding as well; however, with the new system, even if a group of students is still very large, the students will have several weeks during the semester to study by themselves (working on supervised academic activities). During these weeks, they are to attend only some classes in very small groups where they can be evaluated and supervised by the teacher.

As was mentioned above, the new system implies dramatic changes, especially to the Spanish system, such as new plans for degrees; the establishment of new objectives for each grade that include competences, skills and abilities to be acquired by the students; and changes in the methodology used. As a result, it becomes important to test whether all of these changes are worthwhile.

METHODOLOGY

There are several approaches to measuring efficiency (Herrero 2005). We have applied a modification of a non-parametric mathematical method, the DEA technique, originally developed by Charnes, Cooper and Rhodes (1978). According to the classical definition of efficiency (Charnes et al., 1981), and using an output orientation, a unit is said to be efficient if it cannot increase any of its outputs without increasing any of its inputs or decreasing any of the other outputs. When using an input orientation, a unit is said to be efficient if it cannot decrease any of its inputs without decreasing any of its outputs or increasing any of the other inputs.

Because of the nature of the objective of our work, we have used an output orientation. In this case, we are not interested in keeping the results constant while decreasing our input levels because universities are not interested in enrolling students with lower levels backgrounds. On the contrary, universities are interested in getting the best out of their students, trying to obtain as high-quality results as possible. Thus, we have used a model that seeks to maximise outputs (an output-oriented model) given the input levels of the students.

While many studies have been developed to compare the efficiency of university departments, there are not as many that study the efficiency of university students. Mc Millan and Chang (2003) ranked Canadian universities using DEA and SPF (stochastic production frontiers) techniques. Fandel (2007) classified some German universities using DEA in order

to shed light on how to redistribute funds for teaching and research among universities. Rodgers and Ghosh (2001) analysed the individual efficiency of students and related these data to their input levels (entry qualifications on arrival at university) and subjects taken. Johnes (2006) undertook a study at different levels to explore the efficiency of different universities, different departments and different students. Smith and Naylor (2001) also analysed both the performance of UK universities and the efficiency of students as related to personal characteristics.

The procedure we used is a modification of the technique proposed by Charnes et al. (1981). These authors assumed in their models constant returns to scale (CRS), whereas we have incorporated a convexity restriction into our models (as defined by Banker, Charnes and Cooper, 1984) to allow for non-increasing returns to scale (NIRS). This choice allows us to distinguish programme and managerial efficiency under the assumption of non-increasing returns to scale. In contrast to the assumptions of CRS, we have made the model more flexible by allowing decreasing returns to scale (DRS) to conform to the classical assumption in economics of non-increasing returns to scale in production processes. Varying returns to scale (VRS) could have been used instead, but NIRS has been preferred because it helps to avoid the appearance of infeasibilities.

When several different methods can be used in a firm process, the decision-maker will not always be interested in the individual efficiency levels of different firms, but instead may focus on the overall process (or programme efficiency) in order to choose the most efficient programme. The decision regarding which programme should be used can be made by observing the efficiency of the units based on the different methods. In order to avoid the influence of the inefficiency that is inherent to each of the firms, it seems necessary to distinguish between management efficiency and efficiency that comes as a result of the method employed. Charnes, Cooper and Rhodes (1981), with their idea of an “inter-envelope”, compared the efficiency of two different educational programmes. They developed a method that provided for programme and managerial efficiency (for some applications of this method, see for example Charnes et al., 1981 or Johnes, 2006; or, in a very different context, see Pascoe and Herrero, 2004).

This technique has been applied to students who began their studies of Business Administration at the University Pablo de Olavide (UPO) in the academic years of 2004/05

(under the Spanish traditional system, TS) and 2005/06 (the year of implantation of the ECTS project pilot). Therefore, the technique has allowed us to distinguish inefficiency due to the students from inefficiency resulting from the educational system used in each year.

Following Charnes, Cooper and Rhodes (1981), we carried out our analysis in three phases. In the first phase, we solved a separated DEA model for each academic course—that is, for each model, we took as the reference group only those students using the same educational programme as the student being evaluated. This is just a standard DEA analysis in which we compare each student with his classmates in the same academic track (and the same educational programme). An individual efficiency measure was obtained for each student in each of the programmes. These efficiency rates represent the individual efficiency of each of the students (the quality of his performance given his input level when he is compared with the rest of his colleagues). This is what Charnes et al. (1981) have defined as managerial efficiency (ME). Therefore, *managerial efficiency* is what is commonly known as technical efficiency: we compare a student with the rest of the students in his group and achieve an efficiency measure for his performance. The ME of a given student gives us an idea of how well this student *manages* his resources to achieve good results. This can be seen graphically in Figure 1, where we have graphed an example assuming a case of one input and one output. From this figure, we observe that there are two educational programmes. The managerial efficiency associated with the students who studied in educational programme 1 should be associated with the distance of the students (the “X”) from the dashed frontier, whereas the managerial efficiency associated with the students that studied in educational programme 2 should be associated with the distance of the students (the dots) from the solid line frontier.

Figure 1 around here.

Second, the efficiency rate of each of the students enrolled in a given academic year was calculated in comparison to that of the group of students enrolled in the other academic year—that is, we compared each of the students of one educational system with the students of the other system. Therefore, in the second phase, if a certain pupil studied under the ECTS system, we calculated his efficiency with respect to the group of students in the previous year (when the traditional system was in use). Analogously, if a certain pupil studied under the

traditional system, we calculated his efficiency with respect to the group of students in the following year (when the ECTS system was in use). In order to carry out this step, a super-efficiency model has to be used (see Andersen and Petersen, 1993) so that the resulting efficiency rate can be higher than 1. Note that the efficiency scores we achieved using this step represent the *total efficiency* (TE). The total efficiency of a given student represents the efficiency of this student in achieving good results given his input levels for whatever reason, either because of how he manages his own resources (the inefficiency inherent in each of the students, the ME) or because of the inefficiency of the educational programme under which he has been studying (programme efficiency, PE, which is not related to the student's individual qualities, but instead has to do with the educational programme in place). In Figure 1, the total efficiency of each student in programme 2 is associated with the distance of each of the dots (students in educational programme 2) from the dashed frontier (the efficient frontier of educational programme 1). The total efficiency of each student in programme 1 is associated with the distance of each of the "X" (students in educational programme 1) from the dashed frontier (the efficient frontier of educational programme 1).

Finally, we calculated the programme efficiency (PE) of each of the systems. This is given by the ratio of total efficiency over managerial (or student) efficiency:

$$TE = ME * PE \Rightarrow PE = TE/ME.$$

Programme efficiency represents the part of total efficiency that is due exclusively to the educational programme used. A student may be perfectly efficient in achieving his outputs given the level of input usage, but it could well happen that the educational programme under which he studied was not appropriate for him, and that as a consequence, he was unable to achieve the level of results that he might have achieved had he studied under another educational programme (as in the case of student C in Figure 2, upon which we will comment later).

In our study, we carried out these steps that allowed us to consider two groups, one of them for the students who began their studies in the first year of LADE, 2004/05 (when the TS was in use), and another for those who began their course of study in the year of 2005/06 (when the ECTS pilot-project was implemented). Therefore, the analysis must be carried out in three phases.

In the first phase, we calculate the efficiency of each student as compared to the rest of the students in the same academic year (under the same educational programme). Therefore, the following DEA model must be solved for each student:

$$\begin{aligned}
 &\text{Maximize} && \theta_{j_0,1} \\
 &\text{Subject to} && x_{j_0,c} \geq \sum_{j=1}^{n_c} \lambda_j x_{j,c} \\
 &&& \sum_{j=1}^{n_c} \lambda_j y_{r,j,c} \geq \theta_{j_0,1} y_{r,j_0,c} \quad r=1,\dots,7 \\
 &&& \sum_{j=1}^{n_c} \lambda_j \leq 1 \\
 &&& \lambda_j \geq 0, \quad j = 1, \dots, n_c,
 \end{aligned} \tag{1}$$

where $x_{j,c}$ corresponds to the input level of student j in academic year course c (c being equal to either 04/05 or 05/06) and $x_{j_0,c}$ to the input of the student under evaluation in each model in academic year c . Analogously, $y_{r,j,c}$ represents the r output (mark obtained in subject r) of student j in year c , and $y_{r,j_0,c}$ represents output r of the DMU under evaluation in year c . The n_c units in the reference set are those students in the same course as the student under evaluation. The subscript j_0 stands for the unit under evaluation and ranges from 1 to the total number of observations ($n_{04/05} + n_{05/06}$). Note that the first $n_{04/05}$ observations correspond to the students in academic year 04/05 and the following ones to those in academic year 05/06; that is, $j_0 = 1, \dots, n_{04/05}, n_{04/05}+1, \dots, n_{04/05} + n_{05/06}$.

The value of $\theta_{j_0,1}$ ($1 < \theta_{j_0,1} < \infty$) corresponds to the proportional increase in the outputs that would make student j_0 efficient. The managerial efficiency (ME) associated with DMU j_0 is given by:

$$ME_{j_0} = 1/\theta_{j_0,1}$$

which varies between zero and one.

In the second portion of the analysis, we created a similar set of DEA models to calculate the efficiency of the students in each educational programme in comparison with the students in the other educational programme. This means that every time we analyse a student of a certain educational system, we have included in the reference set the students in the other educational system (in the opposite academic course from the student under analysis). Thus, we calculate how good this student is compared with the students in the other programme; if his efficiency is similar to that obtained in step one (when he is compared to the students in the same programme), this would mean that the educational programmes perform equally well for this student.

In order to carry out this step, a super-efficiency model has to be used. This model, when we analysed the students studying under the TS, is given by:

$$\begin{aligned}
 &\text{Maximize} \quad \theta_{j_o,2} \\
 &\text{Subject to} \quad x_{j_o, c=05/06} \geq \sum_{j=1}^{n_{04/05}} \lambda_j x_{j, c=04/05} \\
 &\quad \sum_{j=1}^{n_{04/05}} \lambda_j y_{r,j, c=04/05}^* \geq \theta_{j_o,2} y_{r,j_o, c=05/06}^*, r=1, \dots, 7; \quad (2.1) \\
 &\quad \sum_{j=1}^{n_{04/05}} \lambda_j \leq 1 \\
 &\quad \lambda_j \geq 0, \quad j = 1, \dots, n_{04/05}
 \end{aligned}$$

This model has to be used to analyse each student who studied under the TS ($j_o = 1, \dots, n_{04/05}$).

When we analysed the students who studied under the ECTS system, the model was:

$$\begin{aligned}
 &\text{Maximize} \quad \theta_{j_o,2} \\
 &\text{Subject to} \quad x_{j_o, c=04/05} \geq \sum_{j=1}^{n_{05/06}} \lambda_j x_{j, c=05/06} \\
 &\quad \sum_{j=1}^{n_{05/06}} \lambda_j y_{r,j, c=05/06}^* \geq \theta_{j_o,2} y_{r,j_o, c=04/05}^*, r=1, \dots, 7; \quad (2.2)
 \end{aligned}$$

$$\sum_{j=1}^{n_{05/06}} \lambda_j \leq 1$$

$$\lambda_j \geq 0, \quad j = 1, \dots, n_{05/06}$$

where $TE_{j_o,2} = 1/\theta_{j_o,2}$ represents the total efficiency (TE) of unit j_o .

This model has to be employed for each student who studied under the ECTS system ($j_o = n_{04/05}+1, \dots, n_{04/05}+n_{05/06}$).

Finally, because total efficiency (TE) is equal to managerial efficiency (ME) times programme efficiency (PE)— $TE = ME * PE$ —we can calculate the PE for each unit simply as the ratio of the theta obtained in the second set of models [model (2.1) and model (2.2)] over the theta obtained in the first set of models [model (1)]:

$$PE_{j_o} = \frac{TE_{j_o}}{ME_{j_o}} = \frac{1/\theta_{j_o,2}}{1/\theta_{j_o,1}} = \frac{\theta_{j_o,1}}{\theta_{j_o,2}} \quad (3)$$

Note that $\theta_{j_o,2}$ represents the total efficiency (TE) of each unit j_o , where j_o ranges from 1 to $n_{04/05}+n_{05/06}$. That is, it represents the total efficiency of each of the students: those who study under the traditional system (model 2.1) and those who study under the ECTS system (model 2.2).

This can be seen graphically in Figures 1 and 2, wherein we have graphed two examples assuming one input and one output. In order to create Figure 1, we have considered two educational programmes and have assumed that educational programme 1 is more efficient than educational programme 2. Therefore, we can distinguish two types of inefficiency associated with each unit: one due to the inherent inefficiency of the unit itself (managerial inefficiency, given by the distance of the unit to the frontier associated with that unit) and inefficiency due to the educational programme used. For a unit operating under educational programme 2 in the example of Figure 1, the programme should be associated with the distance between the two frontiers.

Figure 2 presents another example, this time using two other educational programmes. The frontier associated with educational programme 1 is represented by dashed lines, and the observations associated with this programme are represented by X's. The frontier associated with educational programme 2 is represented by straight lines, and the observations associated with this programme are represented by dots. We have assumed that educational programme 1 is more efficient than educational programme 2 only for the students with the lower input level. For students with higher levels of input, educational programme 2 should perform better. Therefore, we can again distinguish between two types of inefficiency associated with each unit: one due to the inherent inefficiency of the unit itself (managerial inefficiency, given by the distance of the unit to the frontier associated with that unit) and inefficiency due to the educational programme used (which should be associated with the distance between both frontiers). For example, if we consider a student such as A (Figure 2), who is studying under educational programme 2 (therefore represented by a dot in Figure 2), we can see that the managerial efficiency associated with this student A is given by the ratio $ME = XA/XA'$ (note that this is less than 1; therefore, unit A is inefficient). This should represent the level of performance of student A as compared with his mates (those in the same academic year and studying under educational programme 2). Had he been an efficient student, he could have been in a situation such as that of student A', who reaches a higher output level than A using the same input level and the same educational programme. When comparing student A with the students of educational programme 1 (i.e., with the frontier represented by dashed lines), we observe that the student may be even more efficient (as efficient as A'') and that total efficiency should be given by $TE = XA/XA''$. Here, total inefficiency is the inefficiency due to the student (managerial inefficiency) and the inefficiency due to the educational programme used (programme efficiency). On the other hand, programme inefficiency as associated with this unit (i.e., inefficiency due to the educational programme used by student A, or in the case, the inefficiency of educational programme 2 for student A) is given by the ratio of total efficiency to managerial efficiency—that is, $PE = (XA/XA'') / (XA/XA') = XA'/XA''$. This means that if student A had studied under educational programme 1 (instead of 2), then he could potentially have achieved even better results because he could have studied in the same context as A'' (rather than A').

Analogously, the managerial inefficiency of point B (note that for this unit, educational programme 1 is being used) is given by YB/YB' (again less than 1; unit B is inefficient). Its programme efficiency would be given by YB'/YB'' . Therefore, programme efficiency should be higher than 1 (a super-efficient unit). This means that if student B had been studying using educational programme 2, he would (potentially) have been more inefficient—i.e., he would have achieved worse results.

If we have a student, such as C, then managerial efficiency will be equal to 1 (because he will be on the frontier for his group). Student C will then be perfectly efficient in terms of managerial performance. By contrast, his total efficiency will be lower than 1 (because his performance could be as that of C''). Obviously, if his managerial efficiency is equal to one (perfectly efficient) but total efficiency is less than 1 (inefficient), then his overall inefficiency will be due exclusively to the educational programme under which he is studying (programme 2). Had student C used educational programme 1, he could have reached a level of achievement like that of student C'' (who has a higher output level for the same amount of input).

 Figure 2 around here.

Putting numbers to some of the previous examples, we could assume that student A in Figure 2 (a student of educational programme 2) could achieve (in step 1 of the methodology process) an individual efficiency rate of 0.8 and a total efficiency rate of 0.7. This would mean that when compared to that of his classmates (those in the same course), his performance would be equal to 0.8. This figure would decrease when we compared him to the students in the other programme (which would yield an efficiency score of only 0.7). This would mean that part of the total inefficiency would be due to managerial inefficiency (as the student would be inefficient, with an efficiency rate of 0.8), while another part of the total inefficiency would be due to the educational programme used (programme efficiency). This would explain why his total inefficiency would be 0.7—or, in other words, lower than 0.8. Had we used educational programme 2 with this student, he could have potentially achieved better performance (as did A'').

CASE STUDY AND VARIABLES USED

Given that the efficiency rates are obtained based on the relationship between inputs and outputs, it is important to choose the appropriate inputs and outputs for our study. Johnes (2006), in her study of graduates in economics at UK universities, suggests that an appropriate input is a variable that reflects the quality of a student's background when he enrolls at the university; likewise, outputs should reflect the quality of students' results.

Several inputs and outputs have been chosen in the literature on education studies, but most of them are similar in considering as their input to the level of initial student quality, which is indicated by his entry qualifications. We must take into consideration that other variables, such as those related to socio-economic background (or other background factors), are likely to be relevant as inputs and could have been included in the study. Unfortunately, these factors are difficult to measure and are rarely available; however, we should also take into account that these variables are, in a sense, included in the variable "entry qualification". Note that if, for example, a less privileged economic background negatively affects the student's performance, the student will get a lower entry qualification. Therefore, entry qualifications can be considered as indicating a mixture of the actual quality level of the student (i.e., his academic abilities) and the effect of other external factors (such as economic background) on his performance.

In Spain, the entry qualification is the average of the marks each student earned in high school and his mark on a common examination (for all high schools) taken prior to university entry. This exam did not change at all over the two academic years we considered in our analysis. Thus, we feel that entry qualification adequately represents the quality of the student or his academic ability upon arrival at the university. Obviously, including other variables, such as economic background and parents' level of study, would have been desirable; however, these data were not available. Thus, this has been left for future research. In this study, we are trying to identify these and other variables in terms of their ability to explain students' efficiency.

For the academic year of 2004/05, the average value of the entry qualifications of the students (Table 1) was found to be equal to 6.30 (with a standard deviation of 0.78), reaching a maximum value of 9 and a minimum value of 5. For the academic year of 2005/06, the average input value was slightly higher, 6.46, and its standard deviation was 0.82. The maximum input for this year was slightly higher, at 9.47, than that for the previous course, and the minimum value was equal to 5.33.

In the first course in Business Administration, there are seven different subjects that have been modified from the traditional methodology and adapted to the requirements of the pilot-project ECTS. Therefore, we considered seven outputs in our analysis: the marks obtained by each of the students in each of the seven subjects (Accounting, Business Law, Commercial Law, Business Administration, Introduction to Economics, Economic History and Mathematics); we considered them to appropriately represent the students' results. We must note that the teaching staff was the same for both academic years and that the student–teacher ratio did not vary either².

Therefore, we assume that an educational system is efficient if it can appropriately efficient if it is able to keep a student with good qualifications from achieving similarly good results.

 Insert Table 1 about here

With the aim of maintaining the anonymity of the subjects, we renamed them subject 1, subject 2, etc. From Table 2, we can observe that the average values of the marks for the different subjects increased in the year in which the ECTS pilot-project was implemented for the seven subjects considered; however, we must take into account that the average input level of the students had also increased. Therefore, we cannot draw any preliminary conclusions regarding the efficiency of each educational programme from these figures, and we will have to analyse the results of the DEA analysis.

² Note that even if there seem to be fewer students in the 2005/2006 academic year, this figure simply refers to new entrants. The total number of students is basically the same as in the previous year, but in our study, we only consider new entrants (not those that repeating the courses).

In the year of 2004/05, the average value of the marks did not exceed 5 for any of the subjects considered, whereas for the year of 2005/06, average marks higher than 5 were indicated for subjects 3 and 6 (Table 2).

The most significant increase in the average mark was for subject 5, which increased from 1.89 in 2004/05 to 3.94 in 2005/06 (a 108.47% increase); the smallest increase (34.90%) was for subject 3, which was the subject with the highest average mark in 2004/05. Four out of seven subjects showed a smaller deviation around the average mark in 2005/06.

Insert Table 2 about here

RESULTS

Efficiency results.

All models were programmed in GAMS (Brooke *et al.*, 1992). The mean value of the (managerial) efficiency rate of the students in year 2004/05 (table 3) was 0.78 (with a standard deviation of 0.25), whereas this value increased to 0.81 in 2005/06 (with a standard deviation of 0.19).

Insert Table 3 about here

The results indicate a slight increase in relative individual efficiency with the application of the ECTS; however, we must remark that given that efficiency is a *relative* concept in the observations considered, this initial study (corresponding to the first phase) does not provide evidence of efficiency improvement. In order to check this, it is necessary to carry out the second and third phases of the analysis.

In order to test for differences in the distribution of the efficiency rates associated with the two groups (the TS group and the ECTS group), we tried to verify whether each of them

followed normal distributions. The Kolmogorov-Smirnov test indicated that neither set of observations followed a normal distribution. Therefore, we carried out a Mann-Whitney test and a Wilcoxon test (the results of which prove to be equivalent) to check for possible similarities in the distribution of the two groups of efficiency scores. Managerial efficiency appeared to follow similar distributions (see Table 4).

However, we observed that the standard deviation values of the efficiency rates associated with the students in the ECTS system were smaller than the ones associated with the students in the TS educational programme. We carried out a Levene test to ascertain whether the variances were equal. According to the results, we had to reject the null hypothesis that the variance associated with the group of students studying under the traditional system and that associated with the students studying under the ECTS system were equal (Table 4). From this, we can conclude that the relative efficiency levels attained by the students in year 2005/06 under the application of the pilot-project (ECTS) are greater than those of the other group because their relative efficiency reflects less dispersion with respect to the mean (with a standard deviation equal to 0.19) than is the case for the students studying under the previous system (who had a TE average value of 0.78 with a standard deviation equal to 0.25). This means that the students studying under the new system showed more similar performance internally; that is, the difference between the ‘good’ and the ‘bad’ students was reduced.

 Insert Table 4 about here

In the second phase of our analysis, we calculated the total efficiency of the students. We did so by making bilateral comparisons—that is, each student was compared with the students in the opposite academic course. The efficiency values can now be greater than one because the unit being analysed was not included in the reference set. This can be explained through the super-efficiency concept of Andersen and Petersen (1993). The average total efficiency for the students associated with the TS system was found to be equal to 0.75 (with a standard deviation equal to 0.27), whereas the average total efficiency associated with the ECTS system amounted to 0.89 (with a standard deviation of 0.25).

We then divided student efficiency (as obtained in phase 1) by the resulting score (obtained in phase 2), so that we obtained “pure” *programme efficiency* (i.e., the efficiency due to the educational system used for the students), as appears in Table 6.

 Insert Table 5 about here

In this phase of our analysis, we observed that the average value for ECTS programme efficiency was higher than 1 (1.10), whereas the average efficiency rate associated with the observations under the traditional system was less than one (0.93). According to the results (Table 5), the efficiency of the educational system seems to have increased in comparison to that of the traditional system.

In order to verify whether programme efficiency as associated with the two groups was similar, we again used a Kolmogorov-Smirnov test; however, again, the null hypothesis that each of the sets followed a normal distribution was rejected. Therefore parametric tests could not be performed. We then carried out a non-parametric test: the rank-sum-test developed by Wilcoxon (which is equivalent to the U-test developed by Mann-Whitney). Based on the results (as in Table 7), we had to reject the null hypothesis that the efficiency rates of the two groups follow similar distributions. Therefore, we can conclude that the programme efficiency levels of the two systems are significantly different.

 Insert Table 6 about here

We then carried out a Levene test (Table 7) to verify whether, at the least, the variance of the two groups was similar. We could not reject the null hypothesis that the variance levels were equal. Thus, we were able to conclude that the main difference between the distribution levels was in the localisation of the mean. We carried out a Fisher test and other contingency tests to check whether the medians of the two groups were similar. The results of all tests confirmed

at the 0.000 level that the null hypothesis (that average values for programme efficiency for both groups were equal) had to be rejected. Therefore, it can be concluded that on average, the ECTS system outperforms the traditional system in the sense that the majority of the students achieve better efficiency levels (or, at least, can achieve higher potential efficiency levels) under the ECTS system.

Analysis of programme efficiency.

We also extended the analysis of programme efficiency to verify whether the efficiency level associated with the ECTS system was higher for all students or whether, on the contrary, the ECTS system underperformed the traditional system for some students. In Figures 3a and 3b, we have plotted the ECTS and traditional system programme efficiency levels (respectively) for each student versus that student's background (his input level—i.e., his high school grades). Note that individual ECTS programme efficiency for each student represents how well the ECTS system works for this student if we compare that performance level with performance under the traditional system if it had been used. Therefore, an ECTS programme efficiency level higher than 1 for a given student indicates that the ECTS system works better for that student than the traditional system would have done. Analogously, a ECTS programme efficiency below 1 for a given student indicates that the ECTS system achieves worse results for that student than the traditional system would have done. We can make an analogous argument regarding traditional system (TS) programme efficiency.

 Figures 3a and 3b around here

The first conclusion we can draw from Figures 3a and 3b is that although the vast majority of the observations present an ECTS programme efficiency level higher than 1, the opposite occurs for TS programme efficiency. This implies that the ECTS system performs better than the traditional one for the majority of the students, although not for all of them.

From these figures, we can draw the conclusion that the ECTS programme efficiency yields higher values for students with a lower background level. Note that ECTS programme efficiency (Figure 3b) is a measure of the performance of the student under the ECTS programme with respect to the TS efficiency for each student individually. Figure 3b indicates that the students with the lowest background (input levels) may reach efficiency rates of up to almost 80% higher under the ECTS system than under the traditional system. We can observe that the higher the student's input, the higher the student's performance under the TS system in comparison to performance under the ECTS system; however, this difference continues to decline as the students' background level increases, and there seems to be a point of convergence (Figure 3b) where both systems are equally effective (so that the relative efficiency of one programme to another is around 1). Therefore, for the best students, the ECTS system seems to perform similar to the traditional system (Figure 3b).

If we use the same reasoning for the model with the traditional system PE (Figure 3a) as the dependent variable, we can conclude that the traditional system seems to yield worse performance than does the ECTS system for students who demonstrate low and average achievement levels upon leaving high school. The performance of students in the two programmes is similar when the students have higher grades.

CONCLUSIONS

While the ECTS system will be established in less than one year in most European countries, no formal study has analysed the efficiency of the pilot projects that have been implemented since the convergence process began. To the best of our knowledge, this is the first study in which formal efficiency measures have been used to analyse the performance of the new educational system. Although there is a great degree of controversy surrounding the implementation of the ECTS system, this is one of the first steps that has been taken to measure the success of the European Higher Education Area. Therefore, this paper may be of use for subsequent studies that will measure the success of the new system.

The results of this analysis are of great relevance to countries like Spain, France and Germany, whose educational systems differ from the ECTS system to a greater extent than may be true in other nations. While the traditional systems are based more on teaching a high volume of knowledge that the student must acquire, the ECTS is based more on "learning to

learn” under the rubric of “life-long learning”. Because the vast majority of EU countries are to implement the new educational system to reach convergence objectives, studies like the one presented here are of great importance.

In this paper, we have analysed the efficiency of the new educational system associated with the European Space for Higher Education (ESHE) in comparison to the system originally used in Spain. Our study is based on the results of the pilot project carried out at the Pablo de Olavide University (Seville, Spain) for first-year students in Business Administration Studies. We have made use of a modified procedure based on a combination of the frameworks suggested by Charnes *et al.* (1981) and Banker *et al.* (1984), using the Data Envelopment Analysis Technique (DEA). Moreover, we have applied that procedure to management students who began their course of study before (in 2004/05) and after (in 2005/06) the pilot project was implemented. The results show that an improvement occurred in terms of efficiency after the new system was launched.

Furthermore, there are some studies in the literature that compare different educational programmes, but they only show average results. We have gone further in analysing programme efficiency, relating the efficiency of each of the two educational systems with the input level of the students (the entry quality of the students upon their arrival at the university) to see whether the effect of the educational programme is the same for all students or if it varies depending on the type or the quality of the students. We have drawn conclusions that the ECTS system outperforms the traditional system to a great extent for the majority of the students. In general, the difference is quite dramatic, as there may be an improvement of nearly 80%. The difference is particularly great for students with lower grades in high school. It is only for some students with average grades in high school that the traditional system performs similarly to the ECTS system.

In general, it seems that the students with the most advanced background are those who benefit less from the new system. This might be simply because if the majority of the students improve their grades, then those with the highest results stand out to a lesser extent than when the differences in performance are higher. Another reason why the students with less advanced or average academic backgrounds benefit more from the new system might be that under this system, they feel more obliged to study harder on a day-to-day basis because of the structure of ongoing evaluations. Under the traditional system, the less motivated

students or (those who have lower input levels) are evaluated via achievement testing. This may make them adopt a more nonchalant attitude during the course of the semester, so that they may not study as much as they would do if they experienced the pressure of more continuous evaluation. By contrast, improving the results of a great number of students with low-to-medium input levels through the implementation of the new ECTS system could be a good opportunity to increase the general level of success of the educational system. Perhaps these conclusions and those of subsequent studies may give governments greater backing as they attempt to meet the European Higher Education Area requirements in spite of the great controversy that has developed around the Bologna Process.

REFERENCES

- Andersen, P., Petersen, N.C., 1993. "A Procedure for Ranking Efficient Units in Dea". *Management Science*, 39, pp.1261-64.
- Brooke, A. D., Kendrick, D., Meerhaus, A., 1992. "GAMS: A User's Guide", Scientific Press, California.
- CRE, Confederation of EU Rectors' Conferences and the Association Of European Universities, 1999. "Bologna Declaration: An Explanation".
- Banker, R. D., Charnes, A., Cooper, W.W., 1984. "Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis", *Management Science*, 30, 9, pp.1078-1092.
- Charnes, A., Cooper, W., Rhodes, E., 1978. "Measuring The Efficiency Of Decision Making Units", *European Journal Of Operational Research*, 2, pp. 429-444.
- Charnes, A., Cooper, W., Rhodes, E., 1981. "Evaluating Program And Managerial Efficiency: An Application Of Data Envelopment Analysis To Program Follow Through", *Management Science*, Vol.27, 6, pp. 668-697.
- Fandel, G., 2007. "On the performance of universities in North Rhine-Westphalia, Germany: Government's redistribution of funds judged using DEA efficiency measures". *European Journal of Operational Research*, 176, pp. 521-533,
- García-Aracil, A., Navarro-Milla, I., 2006. "Efficiency And Productivity Change In Spanish Public Universities, 1994-2002", Workshop "Eficiencia Y Productividad" 2006.
- Herrero, I., 2005. "Different Approaches to Efficiency Analysis". *European Journal of Operational Research*, Vol. 167, 1, pp. 257-271.

- Johnes, J., 2006. "Measuring Teaching Efficiency in Higher Education: An Application Of Data Envelopment Analysis To Graduates From Uk Universities 1993". *European Journal Of Operational Research*, 174, 443-456.
- Melville, L., Mc Millan, Wing, H.Chan., 2004. "University Efficiency: A Comparison and Consolidation Of Results From Stochastic And Non-Stochastic Methods". *Economics*
- Miranda, A.L., Lanzer, E, A., 2003. "Data Envelopment Analysis –Dea And Fuzzy Sets To Assess The Performance Of Academic Departments; A Case Study At Federal University Of Santa Catarin- Ufsc", Issn 0101-7438.
- Muñiz, M. A., 2002. "Separating Managerial Inefficiency and External Conditions in Data Envelopment Analysis". *European Journal of Operational Research*, Vol. 143, 3, pp. 625-643.
- Ramos, J., "Espacio Europeo De Educación Superior", Web Page Of The Universidad Pablo De Olavide (In Spanish). Retrieved July, 2008:
[Http://Www.Upo.Es/General/Estudiar/Espacio_Europeo/Index_Espacio.Html](http://Www.Upo.Es/General/Estudiar/Espacio_Europeo/Index_Espacio.Html)
- Rodgers, T and Ghosh, D (2001). "Measuring the determinants of quality in UK higher education: a multinomial logit approach". *Quality Assurance in Education*, 9(3), pp.121-126.
- Smith, J & Naylor, R (2001) 'Determinants of degree performance in UK universities: a statistical analysis of the 1993 student cohort' *Oxford Bulletin of Economics and Statistics*, 63, pp. 29-60.

TABLE 1.
Descriptive statistics of the initial levels of the students.

	Year 2004/05	Year 2005/06
Number of students	156	135
Average input level	6.30	6.46
Standard deviation	0.78	0.82
Median	6.11	5.75

TABLE 2.
Average marks for the seven subjects considered.

	Mean		%variation of the mean	Standard deviation	
Subject	Year 2004/05	Year 2005/06		Year 2004/05	Year 2005/06
Subject 1	2.21	3.94	78.28%	3.19	3.01
Subject 2	3.30	4.92	49.09%	3.14	2.28
Subject 3	3.84	5.18	34.90%	2.39	2.5
Subject 4	1.83	3.47	89.62%	2.85	2.86
Subject 5	1.89	3.94	108.47%	2.79	2.86
Subject 6	3.55	5.56	56.62%	3.03	2.28
Subject 7	2.56	3.64	42.19%	3.06	2.70

TABLE 3.
Managerial Efficiency (ME) results (phase 1)

	Year 2004/05	Year 2005/06
Average	0.78	0.81
Standard deviation	0.25	0.19
Minimum value	0.11	0.14
Maximum value	1	1

TABLE 4.
Results of the Wilcoxon and Levene tests (for comparing ME of the two systems).

	TE	Sig.
U Mann-Whitney	10482.50	0.95
W-Wilcoxon	19662.50	0.95
Levene Test	7.59	0.00

TABLE 5.
Total efficiency results.

	TS Total Eff	ECTS Total Eff
Average	0.75	0.89
Standard deviation	0.27	0.25
Minimum value	0.12	0.16
Maximum value	1.27	1.60

TABLE 6.
Programme efficiency results (phase 3).

	TS PE	ECTS PE
Average	0.93	1.10
Standard deviation	0.17	0.17
Minimum value	0.17	0.85
Maximum value	1.27	1.72

TABLE 7.
Results of the Wilcoxon and Levene tests (for comparing PE of the two systems).

	TE	Sig.
U Mann-Whitney	5658	0.00
W-Wilcoxon	17904	0.00
Levene Test	0.02	0.89

Figure 1. Comparison of two educational programmes.

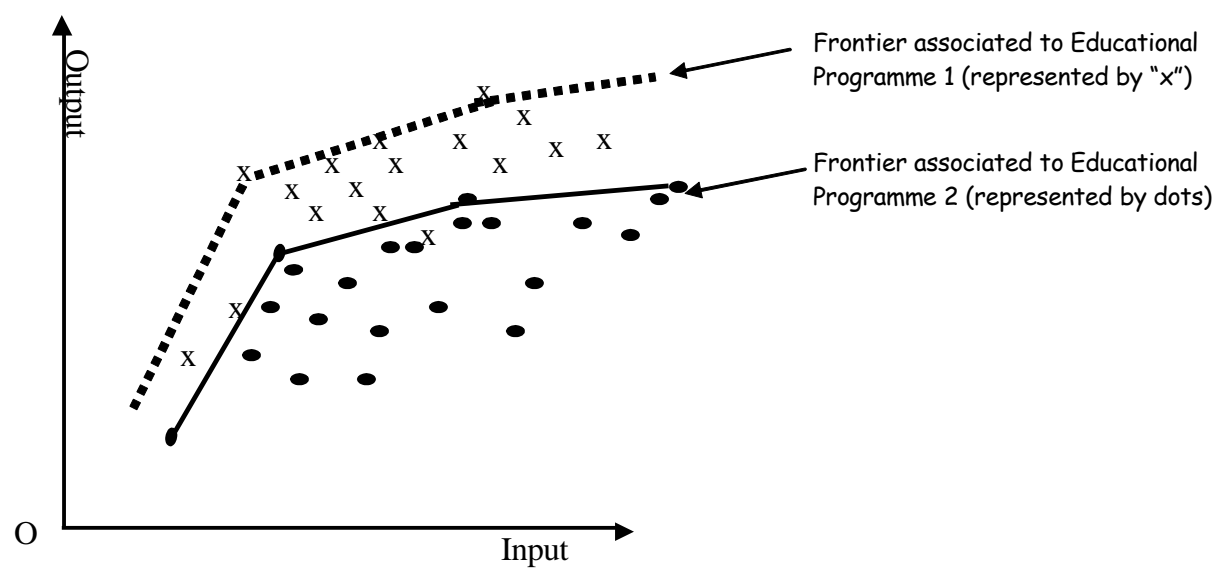


Figure 2. Comparison of two educational programmes.

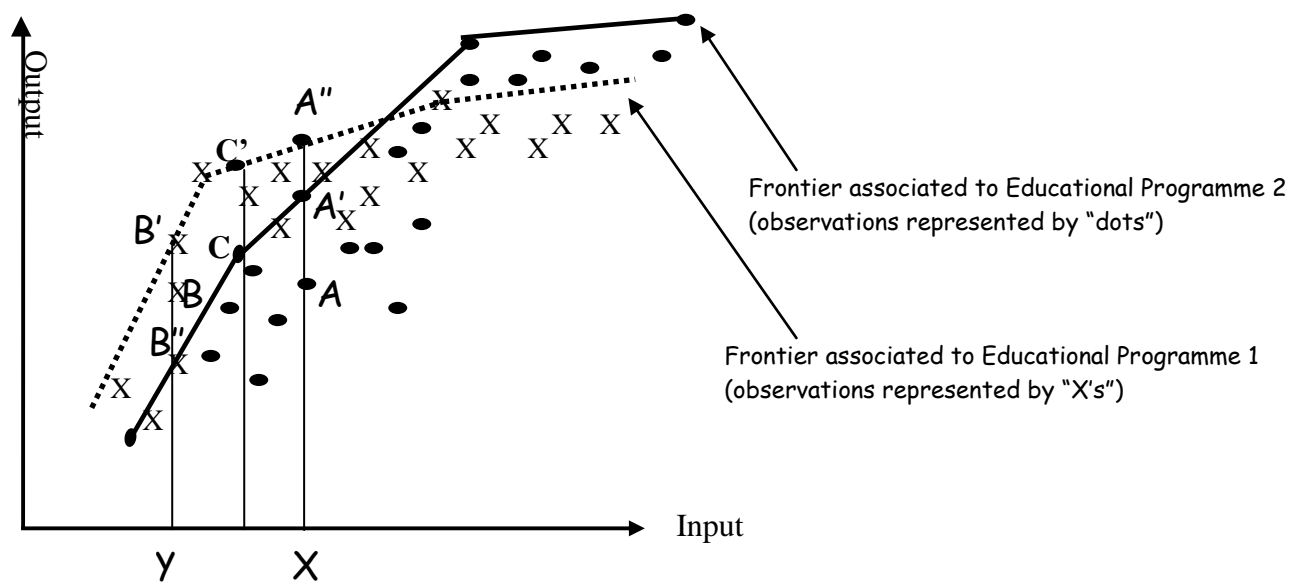


Figure 3a and 3b. TS and ECTS programme efficiencies versus students' backgrounds.

